COMPOSITION AND AMINO ACID PROFILES OF TOMATO SEEDS FROM CANNING WASTES

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Tomato seeds from processing wastes and previously submitted to Hot and Cold Break treatments were demonstrated to be a potential source of nonconventional protein due to high lysine contents even though showing primary limitation for valine. The effect of such thermal treatments on the protein quality, chemical composition and amino acid profiles was observed.

Valine limitation; protein; fat; carbohydrates; fiber and ash contents were: 67 and 74; 33.71 and 36.77; 14.62 and 19.00; 4.76 and 6.35; 41.78 and 33.04; 2.01 and 2.14% for seeds from Hot and Cold Break treatments, respectively. However, due to high fiber content tomato seed meals showed to be more suitable for isolation of protein concentrates.

Keywords: tomato seed protein, tomato seed wastes

The disposal of many cannery wastes usually involves technical, economic and environmental problems. Tomato processing wastes consisting primarily of seeds and skins are often buried, flushed into rivers and streams (KELLEY, 1958) or used as animal feed (EDWARDS et al., 1952; AMMERMAN et al., 1963; BEN-GERA & KRAMER, 1969; KRAMER & KWEE, 1977b). The composition of and isolation of protein concentrate from tomato seeds have been studied by several researchers (BEN-GERA & KRAMER, 1969; TSATSARONIS & BOSKOU, 1975; KRAMER & KWEE, 1977a; CANELLA et al., 1979; CANELLA & CASTRIOTTA, 1980; BRODOWSKI & GEISMAN, 1980; LATLIEF & KNORR, 1983a, b).

The expanding tomato processing industry yields a considerable amount of seeds that could be converted into high protein supplements for an undernourished population. Such conversion would decrease the shortage of high quality protein, and at the same time, help to minimize pollution risks, mainly in developing countries. The purpose of this work was to evaluate the composition of tomato seed wastes submitted to industrial thermal treatments.

1. Materials and methods

1.1. *Preparation of dry defatted seed meals*

Samples of tomato pomace were obtained after commercial extraction of ripe tomatoes (cultivar Petomech AG 16) grown in São Paulo, Brazil, which were submitted either to Hot Break (95 °C 10 min^{-1}) or Cold break (60 °C 10 min^{-1}) treatments. The samples, after a spontaneous fermentation at room temperature were washed with tap water to separate seeds from skins and gelatinous material. The seeds were dried at 45 °C for 48 h in a forced air oven, comminuted with a grinder model 4-E (Quaker City Mill, Pa.) and defatted with n-hexane for 6 h in a Soxhlet apparatus, following by a regrinding in a hammer mill fitted with a 40 mesh screen.

1.2. *Analytical methods*

1.2.1. *Crude protein.* Total nitrogen content was determined by micro-Kjeldahl analysis following the method as described by BAILEY (1967) and crude protein expressed as N(%) × 5.85.

1.2.2. *Amino acids.* Appropriate amounts of defatted seed meals were hydrolyzed in sealed tubes at 110 °C for 24 h with 6 mol l^{-1} HCl. The excess of hydrochloric acid was evaporated under vacuum, with occasional addition of distilled water 3–5 times. The residue was dissolved in 10% isopropanol (v/v) then filtered and the final volume made up to 5 cm^3 in a measuring flask with the same solvent. Methionine and cystine were analyzed after oxidation with performic acid by the procedure of MOORE (1963). The percentage of each amino acid was determined in a Beckman model 120 C automatic amino acid analyzer, following the technique described by SPACKMAN and co-workers (1958). Tryptophan was determined according to MERTZ and co-workers (1975).

1.2.3. *Total carbohydrates.* Carbohydrates were extracted with 85% methanol (v/v) (SOUTHGATE, 1969) and determined with anthrone reagent (MORRIS, 1948).

1.2.4. *Other analyses.* Moisture, crude fat and ash were determined according to standard methods (AOAC, 1980). Crude fiber was estimated by difference. The nutritional quality of tomato seed meal proteins was evaluated by their chemical scores.

1.2.5. *Statistical analysis.* Mean values of results, standard deviations and comparison of mean values (*F* test) between components of three samples for each thermal treatment, were calculated with four replicates, except for amino acid analyses which were performed in duplicate on a composite of the three original samples per treatment.

2. Results and discussion

The proximate composition of tomato seed meals is shown in Table 1. Average crude protein ranged from 33.71% to 36.77% for seeds submitted to Hot and Cold Break treatments, respectively. This fact indicates that the high temperature of the Hot Break treatment resulted in more noticeable losses of nitrogen compounds of tomato seeds. The data obtained for both treatments were lower than those reported by ANTALDI and PIVA (1967); VIGO and co-workers (1977); CANELLA and CASTRIOTTA (1980) or MORAD and co-workers (1980), but higher than those obtained by TSATSARONIS and BOSKOU (1975); CANELLA and co-workers (1979); BRODOWSKI and GEISMAN (1980) or RAKHMETOVA (1980).

Ash and fat contents were found to be lower than the results observed by other authors (TSATSARONIS & BOSKOU, 1975; CANELLA et al., 1979) but quite similar to the data presented by CANELLA and CASTRIOTTA (1980). While ash was not affected by the temperature the lower fat content of seeds submitted to Hot Break treatment showed such influence. The same effect of high temperature was demonstrated by the lower carbohydrates in the Hot Break seed meals.

Although crude fiber was estimated by difference, the high values observed could impair the use of tomato seed meals as a food supplement. As a consequence these by-products may be more suitable for obtaining pure protein isolates.

The amino acid profiles are given in Table 2. The amino acid composition, for both treatments, is similar to the data reported by TSATSARONIS

Table 1

Effect of industrial thermal treatments on the composition of tomato seed meals
(g per 100 g of dry matter)

Component	Hot Break		Cold Break		Level of significance
	$\bar{x}$	±s	$\bar{x}$	±s	
Moisture	3.11	0.07	2.70	0.02	**
Crude protein	33.71	0.18	36.77	0.42	**
Total carbohydrates	4.76	0.19	5.35	0.05	**
Crude fat	14.62	0.19	19.00	0.10	**
Crude fiber*	41.78	0.11	33.04	0.43	**
Ash	2.91	0.09	2.14	0.02	ns

*: estimated by difference
$\bar{x}$: mean value
±s: standard deviation
ns: not significant
**: significant at P = 1% probability level
Number of measurements, (n) = 4

Table 2

Amino acid composition of tomato seed as affected by industrial thermal treatments

Amino acid	Hot Break meal	Cold Break meal	Change due to thermal treatment (%)
	(g amino acid per 100 g protein)[a]		
Lysine	8.18	8.41	− 2.73
Histidine	3.61	4.04	−10.64
Arginine	9.60	9.83	− 2.34
Aspartic acid	10.93	11.40	− 4.12
Threonine	3.26	3.99	−18.55
Serine	4.39	4.52	− 2.88
Glutamic acid	13.25	13.65	− 2.93
Proline	5.53	6.53	−14.18
Glycine	5.25	5.38	− 2.42
Alanine	3.52	3.62	− 2.76
Cystine	2.70	2.42	+11.57
Valine	3.69	4.43	−16.70
Methionine	2.58	2.33	+10.73
Isoleucine	3.84	4.51	−14.86
Leucine	5.65	6.01	− 5.82
Tyrosine	4.74	5.29	−10.40
Phenylalanine	4.74	5.77	−17.85
Tryptophan	1.16	1.26	− 7.94

[a]The duplicate samples presented values not exceeding a ±5% deviation according to the echniques used.

and Boskou (1975); Canella and co-workers (1979); Canella and Castriotta (1980); Brodowski and Geisman (1980); Latlief and Knorr 1983a), except for the higher values found for lysine, histine, proline and cystine and for the lower value for glutamic acid. Lysine contents as reported

Table 3

Chemical Scores (CS) and A/E ratios of tomato seed meals in comparison with hen's egg protein

Amino acid	Egg protein A/E	Hot Break meal		Cold Break meal	
		A/E	CS	A/E	CS
Isoleucine	110	95	86	101	92
Leucine	175	140	80	135	77
Lysine	143	202	141	189	132
Methionine + Cystine	116	130	112	107	93
Phenylalanine + Tyrosine	190	234	123	249	131
Threonine	96	80	83	90	94
Valine	136	91	67	100	74
Tryptophan	35	29	83	28	80

herein seem to be uncommon compared to the highest value (6.6 g per 100 g protein) reported by Brodowski and Geisman (1980). This finding could be attributed to the fact of beside being under genetic control, protein can be greatly influenced by factors of cultivation and environment, such as availability of nitrogen to the plant (Johnson et al., 1972).

It is worthwhile to observe the trend that amino acid composition is affected by thermal treatment. Noticeable losses with Hot Break process occurred in relation to essential amino acids, threonine, valine, isoleucine and leucine. However, the unexpected retention of sulfur containing amino acids must be the objective of further studies.

Table 3 shows the A/E ratios and percentages of limitation compared to hen's egg protein (Lajolo et al., 1982). While valine is limiting (67% and 74% for Hot Break and Cold Break meals, respectively) and somewhat deficient in other amino acids, tomato seed proteins could be used to improve the nutritive value of low lysine foods while they lack antinutritional factors (Geisman, 1981).

Despite several technological problems, such as seed drying or protein concentrate isolation, tomato seed wastes appear to be a promising and potentially valuable protein source for improving human diets, instead of simply being discarded.

3. Conclusions

The aforementioned results allow the following conclusions:

The temperature used in Hot Break treatment reduced the protein, fat and carbohydrate contents of tomato seed meals.

As a consequence of their high fiber content tomato seed meals are more suitable for obtaining protein isolates.

A trend that amino acid contents could be affected by heat was observed. In this respect further studies are required with sulfur containing amino acids.

Although some amino acids (mainly valine) are limiting, tomato seed protein would still be a promising source for supplementation of low lysine foods.

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INVESTIGATION OF THE ADDITIVITY OF FLOUR CHARACTERISTICS IN TWO-COMPONENT WHEAT FLOUR MIXTURES

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Baking quality, pastry and protein properties of two-component wheat flour mixtures were tested in model experiments. The four basic flour samples comprised a wide range, almost three orders of baking quality (Jubilejnaja 50, MV 8, Baranjka and GK Csilla of the year 1986).

It was established that some of the characteristics additioned in the course of mixing means a high correlation between the properties as measured or calculated on basis of composition. Properties studied were: water absorption capacity, valorigraph value, SDS sedimentation value.

However, other properties (loaf volume, largest cross-section), important from the point of view of the final product, did not prove additive at all. Results corresponded highly with the experiences of BOLLING (1980).

The experiments permit the conclusion that the rheological properties of the pastry or the gluten of individual flours highly affect the baking quality of the mixture obtained from them. The mixture of a flour producing short, firm texture and another containing softened gluten may give a loaf of optimal volume although the quality of the two flours is far from optimal. The results point to the importance of the rheological properties of wheat true to variety for the baking industry. The deliberate utilization of the combinative capacity of different flours may improve the economicalness of the milling and baking industries while simultaneously satisfying the requirements of the consumer.

Keywords: wheat flour mixtures, baking quality, additivity of flour characteristics

The processing of wheat is an economic activity aimed at producing from the available raw material the best possible product at the lowest possible cost.

A heterogeneity of quality is characteristic of the wheat varieties in general cultivation. This is brought about mainly by the fact that the varieties giving a high yield and resistant to plant diseases have a lower baking quality while the varieties of high baking quality have a lower yield. Due to the frequently observed approach oriented at high yield the edible wheat varieties produced by the agriculture differ in their composition and structural characteristics.

The baking industry, in order to be able to produce bread of uniform quality, needs flour of uniform quality. Only meeting this requirement makes possible the optimization of technical processes.

It is an observation of old standing that by mixing the proper varieties a flour blend meeting the above requirement can be produced. The mixing